






CALCULATION PACKAGE COVER SHEET

Client: Gowanus Canal Remedial Design Group (RD Group) **Project:** Gowanus Canal Superfund Site **Project #:** HPH106A

TITLE OF PACKAGE: THERMAL DESORPTION ACCEPTABILITY EVALUATION

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REVISION HISTORY:

NO.	DESCRIPTION	DATE	CP	APC	CC	CA
0	TB4 Pilot Study Design – Issued for Bid	5/19/2017	RH	JJB	JJB	JFB

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THERMAL DESORPTION ACCEPTABILITY EVALUATION

INTRODUCTION AND PURPOSE

The dredged material to be removed from the 4th Street Turning Basin (TB4) will be comprised primarily of overlying recently deposited soft sediment with a lesser volume of alluvial and glacial native deposits. According to the EPA Feasibility Study (FS), reactivity, pH, ignitability, and toxicity characteristic leaching procedure (TCLP) data indicate that untreated sediment from the Gowanus Canal (Canal) would not be considered as a characteristic hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Further testing performed as part of the PD-10/21 Treatability Study also indicates that Canal sediment can be managed as a nonhazardous waste. The potential options for managing nonhazardous waste include beneficial use such as placement as daily cover at a landfill or disposal at a RCRA Subtitle D landfill. Both options would require further treatment of the dredged material to meet site-specific acceptance criteria. Consistent with the ROD, sediment treatment and disposal methods are anticipated to vary based on the reach and contaminant levels. Excluding areas of the Canal with elevated PCB and lead concentrations, the ROD prescribes end-placement of dredged material for beneficial use such as daily landfill cover. The ROD further indicates that NAPL-impacted material is to be thermally treated prior to beneficial use end-placement.

The ROD has selected Disposal Option A: Off-Site Thermal Desorption and Beneficial Use for NAPL-impacted sediments removed from the Upper and Middle reaches of the Canal (RTA1 and RTA2). Dredged sediment from TB4 will undergo solidification/stabilization (S/S) either on-site via in-barge mixing or off-site at a commercial processing facility. Following S/S treatment, the resulting processed dredged material (PDM) will be sampled and tested to determine if the material meets the acceptance criteria of the selected beneficial use end-placement facility. If PDM fails to meet the acceptance criteria, PDM will be transported to a thermal treatment facility and thermally treated prior to beneficial use end-placement. The treatment residuals would be destroyed in an afterburner and PDM would be transported for beneficial use such as daily cover at a landfill. The ROD recognizes that total PCB and lead concentrations that may be present in the sediment in some areas of the Canal may preclude this treatment option. However, historical sediment analytical data suggest that the soft sediment and underlying native material to be removed during the TB4 Pilot Study do not contain elevated concentrations of PCB or lead.

The purpose of this calculation package is to assess the acceptability of S/S treated dredged sediment removed during the TB4 Pilot Study for processing at a thermal desorption facilities in

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the New York/New Jersey geographic region. Facilities outside of the region were not considered due to anticipated elevated costs associated with transportation.

DESIGN CRITERIA AND MAJOR ASSUMPTIONS

Per the Basis of Design Report, the ex-situ sediment treatment objectives are as follows:

- Off-site thermal desorption of the NAPL-impacted sediments dredged from the Canal, followed by beneficial use off-site (e.g., landfill daily cover), if possible; and
- Off-site stabilization of the less contaminated (non-NAPL-impacted) sediments dredged from the Canal, followed by beneficial use off-site.

The major assumptions for ex-situ treatment are:

- The sediments within TB4 are not a characteristic hazardous waste based on the data provided in Table I-20 of the FS and the results of the PD-10/21 Treatability Study.
- The FS and ROD do not identify any potential listed waste.
- As identified in the ROD, some areas of the Canal may contain concentrations of PCBs and lead that may preclude some treatment and beneficial use options. Sediments from these areas will be managed separately in accordance with the appropriate regulations. Dredged material removed during the TB4 Pilot Study will not contain PCB and lead concentrations that would result in the need to manage the material separately.

METHODOLOGY

The results of the PD-10/21 Treatability Study were used to evaluate both the applicability of thermal desorption and end-use acceptability of the thermally treated materials. Based on these requirements, material management options have been developed for the TB4 Pilot Study.

Although actual thermal desorption testing was not performed on samples from the PD-10/21 Treatability Study, the samples were analyzed for a set of thermal characterization parameters commonly required by thermal desorption facilities for purposes of establishing operating conditions for the treatment of the dredged material, such as temperature and residence time. These parameters which included ignitability, corrosivity, reactivity, and toxicity were captured in the analytical testing programs for testing of the stabilized material from the stabilization treatability study and filter cakes from the dewatering treatability study.

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The data obtained from the PD-10/21 program provides the input parameters for thermal treatment facilities to evaluate the feasibility and operational parameters for thermal treatment of the dredged material. For the purposes of this calculation package, rather than limiting the analysis to analytical data obtained from samples collected from TB4, sediment samples from all reaches of the Canal were considered. As discussed in the PD-10/21 Report, native material collected from TB4 for the PD-10/21 Treatability Study consisted primarily of a visually un-impacted gray clay. It is anticipated that the native alluvial and glacial dredged material to be removed from TB4 during the TB4 Pilot Study will exhibit chemical characteristics more similar to the native sediment samples collected from RTA-2 and RTA-3. In addition, sediment samples from all reaches are included in this calculation package to increase the sample size and the possible range of chemical characteristics to consider in preparation for the TB4 Pilot Study.

The PD-10/21 analytical data was sent to the following existing facilities for their evaluation:

- ESMI of NY
- Clean Earth, Inc. (Clean Earth)
 - Plainville, Connecticut (CECT)
 - New Castle, Delaware (CENC)
 - Morrisville, Pennsylvania (CEM)
 - Philadelphia, Pennsylvania (CEP)
- Deep Green of NY

A brief description of each facility is provided below.

ESMI

The ESMI Thermal Desorption Unit (TDU) is a direct-fired desorption system located 225 miles north of Gowanus Canal in Fort Edward, New York. The TDU consists of seven principal components: feed system; rotary thermal desorption unit (primary treatment unit), soil conditioning (pugmill), discharge conveyors, cyclone, thermal oxidizer (secondary treatment unit), evaporative cooling chamber, and a baghouse.

Contaminated media is heated to temperatures sufficient to cause contaminants to volatilize and desorb (physically separate; evaporate) from the media in the primary treatment unit (PTU). Upon exiting the PTU, soils are conditioned with water to control dust generation and maximize material

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handling capabilities. Treated soil may be reused onsite or utilized at various locations under existing beneficial use determinations.

Products of combustion combined with the desorbed contaminants are introduced to the process air stream. The system is maintained under a negative pressure to insure gasses are routed to the proper treatment equipment. Larger particles that become entrained in the air stream are removed in cyclones. Volatilized contaminants continue through the cyclone to a thermal oxidizer and are reduced to CO₂ and H₂O. The air stream is then cooled in the evaporative cooling chamber with final particulate removal occurring in the baghouse.

ESMI also provides a mobile thermal desorption unit capable of treating 4,000 to 7,200 tons/week of hazardous, non-hazardous, and high moisture content media on-site.

Clean Earth

Clean Earth has thermal treatment capabilities at four (4) separate facilities in the NY/NJ area as described in the subsection below.

Connecticut - CECT

Clean Earth's Connecticut facility (CT DEEP 110021-CRW, 146-0042/146-0143) was formerly known as Phoenix Soil LLC and is located approximately 110 miles north of the Gowanus Canal site in Plainville, Connecticut. The Phoenix facility is Connecticut's first low temperature thermal desorption facility to obtain a Connecticut DEEP Beneficial Use Determination Permit which enables them to use the treated soil as clean fill throughout Connecticut. They are currently permitted for the acceptance and treatment of non-hazardous soil, NAPL-impacted soil, non-TSCA PCBs, dredged material, petroleum, herbicides, pesticides and solvent impacted soil. The resultant processed material is typically used as clean fill material, landfill cover, road base, and commercial/industrial structure fill. The facility has a maximum daily treatment capacity of 6,000 tons.

Delaware - CENC

Clean Earth's Delaware facility (Resource Recovery Permit #SWO2A16) is a non-hazardous soil treatment, processing and recycling facility located approximately 125 miles south of the Gowanus Canal Site in New Castle, Delaware. The facility is a thermal treatment soil facility that processes a wide variety of volatile and semi-volatile contaminants including NAPL-impacted soils and

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aggregates. While processing the soil, their treatment process separates all metal and non-contaminated aggregate for recycling. The resultant processed material is typically used as landfill cover, commercial or industrial fill, and structural fill. The facility has a maximum treatment capacity of 360,000 tons per year.

Morrisville, Pennsylvania - CEM

Clean Earth's Morrisville, Pennsylvania facility (Solid Waste Permit #301254) is a non-hazardous soil treatment, processing and recycling facility located approximately 75 miles southwest of the Gowanus Canal Site. The facility has both thermal desorption and physical treatment capabilities that accepts a wide variety of volatile and semi-volatile contaminants including NAPL-impacted soils and aggregates. The facility also manages Pennsylvania Clean and Regulated Fill through a physical treatment process so the material can be beneficially used as construction fill and landfill cover and capping. The facility has a maximum daily treatment capacity of 2,400 tons.

Philadelphia - CEP

Clean Earth's Residual Waste Permitted Facility (PADEP Residual Waste Permit 301220) is located in South Philadelphia approximately 100 miles southwest of the Gowanus Canal Site. The facility has both thermal desorption and physical treatment capabilities to handle a wide variety of volatile and semi-volatile contaminants including NAPL-impacted soils and aggregates. Similar to their Morrisville facility, this facility can also manage Pennsylvania Clean and Regulated Fill through a physical treatment process so the material can be beneficially used as construction fill and landfill cover and capping. The facility has a maximum daily treatment capacity of 6,000 tons.

Deep Green

Deep Green is a New York State permitted facility that uses high temperature rotary kiln treatment to thermally destroy petroleum hydrocarbon contaminants in soils creating an inert recycled material. The facility is located approximately 75 miles north of the Gowanus Canal Site in New Windsor, New York. The material generated from the thermal treatment process is typically used as clean back-fill. The facility can process up to 525 tons per day and is capable of storing 7,500 cubic yards (approximately 11,250 tons) of petroleum contaminated soil inside its 25,000 square foot enclosed facility.

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ABILITY TO ACCEPT MATERIAL

Based on a review of the PD-10/21 Treatability Study data, Clean Earth has indicated that the S/S treated sediment from the Gowanus Canal would be acceptable at CECT, CENC, CEM, and CEP. Acceptance criteria for Clean Earth is provided in Attachment 1. As with any waste treatment facility, the actual waste characterization testing results will dictate the acceptability of the processed Gowanus Canal dredged material. The processed materials could be beneficially used as daily cover, capping material or construction fill at landfills and brownfield sites.

Overall, upon review of the PD10/21 analytical data, ESMI and Deep Green indicated that concentrations of dioxins and furans may potentially hinder the ability of the facility to accept dredged material from the Gowanus Canal. Dioxins and furans were more predominantly detected in PD10/21 soft sediment samples than native sediment samples. The dioxin with the highest bulk sediment concentration was 1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin (OCDD). Concentrations of OCDD in untreated soft sediment samples ranged from 0.49 ppb in soft sediment from RTA1 to 12 ppb in soft sediment from TB4. Concentrations of OCDD in untreated native sediment samples ranged from 10 to 300 parts per trillion (ppt). Concentrations of furans were significantly less than dioxins in both the native and soft sediment. Peak concentrations of furans in soft sediment samples ranged from 33 ppt to 970 ppt whereas peak concentrations of furans in native sediment samples ranged from below the detection limit to 16 ppt. Discussions with waste management contractors indicate that facilities further away from the New York/New Jersey harbor area that are less familiar with the presence of dioxins and furans are typically less flexible to accept material containing these compounds.

Following a review of the data sets of the sediment associated with the Gowanus Canal Project, ESMI indicated that the materials would meet the criteria as either historical fill or dredge material with various PAH/SVOC contaminants. However, ESMI does not have soil acceptance criteria for dioxins and furans nor does ESMI have soil cleanup criteria for dioxins and furans. Therefore, based on the data provided, ESMI does not believe that the sediment could be accepted at the facility but should site-specific acceptance criteria be established in the future for the end-use placement of dioxin and furan containing material, ESMI would re-evaluate its ability to accept material from the Gowanus Canal site. However, even if ESMI were able to resolve the dioxin and furan acceptance criteria, some of the soft sediment treatability samples demonstrated metals concentrations (lead, chromium, mercury, and arsenic) that would prohibit the material acceptance because the blend percentage necessary to meet either the residential or non-residential reuse criteria for the facility is not practical.

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Deep Green of NY also indicated that based on the treatability data that the material would not be acceptable at their New Windsor facility due to the presence of dioxins and furans. The elevated concentrations of heavy metals and no BTU organics being present also prohibited the facility being able to accept the dredged material.

A summary of the facilities contacted and information collected is provided in Table 1.

CONCLUSIONS AND RECOMMENDATIONS

Based on the PD-10/21 Treatability Study data, in circumstances for which thermal treatment is appropriate, dredged material would be accepted at Clean Earth's Plainville, New Castle, Morrisville, and Philadelphia thermal treatment facilities. ESMI indicated that due to a lack of established dioxin and furan acceptance criteria for their end placement facilities and the presence of several heavy metals above the residential or non-residential reuse criteria in the soft sediment (arsenic, chromium, lead and mercury) the material would not be acceptable for thermal treatment. Deep Green also indicated that due to the presence of dioxins and furans and elevated total heavy metal concentrations that the material does not meet their facilities acceptance criteria. For full scale dredging in RTA1, the design team should continue discussions with ESMI to determine if site-specific dioxin and furan acceptance criteria have been established for an end-use site.

This calculation package indicates that there are several thermal treatment facilities that would accept dredged material from TB4 based on the results of the PD-10/21 Treatability Study. It is important to note that the chemical characteristics of samples collected during the PD-10/21 Treatability Study represent areas of the Canal with relatively high contaminant concentrations based on historical data. Composite waste characterization sampling of dredged material removed during the TB4 Pilot Study will be required by the sediment processing facilities and end-placement facilities used during the TB4 Pilot Study. This composite waste characterization sampling will be utilized to further inform treatment design and management options for dredged material removed during full-scale dredging operations in RTA1, RTA2, and RTA3.

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TABLE

Table 1. Summary of Regional Thermal Desorption Facilities

Facility	Location	Thermal Process	Materials Accepted	Beneficial Uses	Gowanus Canal Acceptance	Comments	Summary of Correspondence
ESMI	Fort Edward, NY	Low Thermal	Petroleum hydrocarbon contaminants, non-TSCA PCBs	Commercial, industrial or residential fill material	NO	No Dioxin/ furan acceptance criteria, heavy metals restrict beneficial use	September 2, 2016 – e-mail communication with Rob Martin of ESMI of New York
Clean Earth	Plainville, CT	Low Thermal	Non-hazardous Soil, NAPL-impacted soil, non-TSCA PCBs, dredged material, petroleum, herbicides, pesticides and solvent impacted soil	clean fill material, landfill cover, road base, commercial/ industrial structure fill	YES		September 20, 2016 – e-mail communication with Nick Mucci of Clean Earth, Inc.
Clean Earth	New Castle, DE	Low Thermal	Volatile and semi-volatile contaminants including NAPL-impacted wastes and non-hazardous coal tar contaminated soils and aggregates	landfill cover, commercial/industrial fill, structural fill	YES		September 20, 2016 – e-mail communication with Nick Mucci of Clean Earth, Inc.
Clean Earth	Morrisville, PA	Low Thermal	Volatile and semi-volatile contaminants including NAPL-impacted wastes and non-hazardous coal tar contaminated soils and aggregates	construction fill, landfill cover, capping	YES		September 20, 2016 – e-mail communication with Nick Mucci of Clean Earth, Inc.
Clean Earth	Philadelphia, PA	Low Thermal	Volatile and semi-volatile contaminants including NAPL-impacted wastes and non-hazardous coal tar contaminated soils and aggregates	construction fill, landfill cover, capping	YES		September 20, 2016 – e-mail communication with Nick Mucci of Clean Earth, Inc.
Deep Green	New Windsor, NY	High Thermal	Petroleum hydrocarbon contaminants in soils	Clean back fill	NO	Presence of dioxins, elevated total heavy metal concentrations and no BTU organics	September 16, 2016 – e-mail correspondence with Kelly Menzel of Cycle Chem, Inc.

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ATTACHMENT 1
CLEAN EARTH THERMAL ACCEPTANCE CRITERIA

**Clean Earth Sampling Protocol
Morrisville, Philadelphia and New Castle**

PARAMETERS		TOTAL PETROLEUM HYDROCARBONS - TPH GRO & TPH DRO Expanded to C44 (GRAB SAMPLE)	TOTAL SEMI-VOLATILE ORGANIC COMPOUNDS (GRAB SAMPLE)	TOTAL METALS - 8 RCRA + Be, Cr+6, Cu, Fe, Mo, Ni, Ti, V, Zn	TCLP METALS - RCRA + Cu, Ni, Zn	IGNITABILITY	CORROSIVITY (PH)	REACTIVITY - SULFIDE AND CYANIDE	TOX	PCBs	TCLP VOLATILE ORGANIC COMPOUNDS (GRAB SAMPLE)	TCLP SEMI-VOLATILE ORGANIC COMPOUNDS (GRAB SAMPLE)	TCLP HERBICIDES	TCLP PESTICIDES	
METHODS		8015M (expanded to C44)	8260B	8270D	6010/7470	1311/6010/7471	1010A	9040C	SW846 CHAPTER 7.3	9023	8082A	1311/8260B	1311/8270D	1311/8151A	1311/8081B
	FREQUENCY														
HISTORIC FILL/ WASTE PETROLEUM/ USED (WASTE) OIL	Grab Sample Every 250 tons	X								X					
	Grab Sample every 1000 tons		X								X				
	5 point composite - every 1000 tons			X	X	X	X	X	X	X	X		X	X	X
Limit (mg/Kg)					End Use Criteria	Below RCRA Toxicity Level	Negative	> 2 - <12.5	Sulfide <500 Cyanide <250		<48	Below RCRA Toxicity Level	Below RCRA Toxicity Level	Below RCRA Toxicity Level	Below RCRA Toxicity Level

(1) The methods provided are standard EPA methods. The method revisions are subject to change and the most current method should always be utilized by the laboratory.

This is to be used as a guideline for sampling. Sampling frequencies and parameter requirements may be modified at the discretion of the CE Approval staff based items such as site history, levels of contamination and/or source of contamination, etc.

	PARAMETERS	TOTAL PETROLEUM HYDROCARBONS (TPH)	TCL VOLATILE ORGANICS *	TCL SEMI-VOLATILE ORGANICS	TCLP Benzene	PCBs	TOTAL METALS - 8 RCRA	TCLP Lead	IGNITABILITY	TOTAL CYANIDE	TCL PESTICIDES	Total HERBICIDES	PAINT FILTER TEST	RADIOACTIVITY
	METHODS (1)		8015B or CT ETPH	8260B	8270D	1311/ 8260B	8082A	6010/ 7471	1311/ 6010A	1010A	9010	1311/ 8081B	1311/ 8151A	9095
	FREQUENCY													
	VIRGIN MATERIAL (Unused Products - Fuel Oils (#2, #4, and #6), Diesel, Hydraulic Oil)	3-point composite sample every 250 cy	a	a	a			a				b	b	a d
	VIRGIN MATERIAL (Unused Products - Gasoline, Jet Fuel, Kerosene, and Aromatic and Aliphatic Hydrocarbons)	3-point composite sample every 250 cy	a	a	a	c			c,e	a		b	b	a d
	Limit (mg/kg)		Oils: <100,000 Gas: <30,000			<0.5 mg/L	<50		<5.0 mg/L	Negative	<200			No Free Liquids
	WASTE MATERIAL (Used Products - Lubricating Oil, Cutting Oil, Water Soluble Oil, Hydraulic Oil, Quench Oil, and Aliphatic and Aromatic Hydrocarbons)	3-point composite sample every 250 cy	X	X	X		X	X		X	f	b	b	X d
	Limit (mg/kg)		Oils: <100,000 Gas: <30,000			<0.5 mg/L	<50		<5.0 mg/L	Negative	<200			No Free Liquids
	MGP (Coal Tar)	3-point composite sample every 250 cy	X	X	X		X	X		X	X	b	b	X d
	Limit (mg/kg)		Oils: <100,000 Gas: <30,000			<0.5 mg/L	<50		<5.0 mg/L	Negative	<200			No Free Liquids

Notes:

- (1) The methods provided are standard EPA methods. The method revisions are subject to change and the most current method should always be utilized by the laboratory.
- (2) This is to be used as a guideline for sampling. Sampling frequencies and parameter requirements may be modified at the discretion of the CE Approval staff based on items such as site history, levels of contamination and/or source of contamination, etc.
- (3) When Virgin Material is spilled or released with used products or is spilled into urban fill, Waste Material protocol is required.
- (4) TCLP analysis is required for VOCs, SVOCs, Metals, Pesticides and/or Herbicides if total concentrations of individual constituents exceeds 20 times the RCRA Toxicity Characteristic concentrations.
- * - Total Chlorinated Solvents must be <1,000 mg/kg.
- X - Analysis is required.
- a - Written certification from the generator may be used in lieu of analytical results.
- b - Written certification from the generator may be used in lieu of analytical results, unless Site History information indicates pesticides and/or herbicides were used, applied, or spilled.
- c - Soil from aboveground storage tanks containing gasoline requires TCLP Benzene and TCLP Lead analysis. Soil from underground storage tanks containing gasoline requires TCLP Lead analysis only.
- d - Written certification from the generator that identifies that the contaminated media is not radioactive in accordance with NRC and/or DOE regulations may be used instead of testing.
- e - Written certification from the generator may be used in lieu of actual TCLP testing unless Site History information indicates the gasoline spill was prior to 1986.
- f - Analysis for cyanide shall be performed on all media where cyanide was used; otherwise, written certification from the generator may be used in lieu of analytical results.